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(54) ULTRA-TURBINE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide means for increasing heat efficiency of a small type gas turbine with output of about 30 kw to 45% of a large sized composite cycle gas turbine level.
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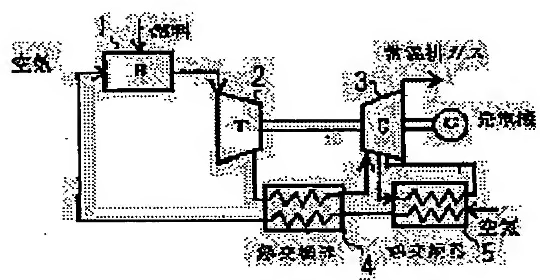

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(22)出願日　平成13年2月20日(2001.2.20)
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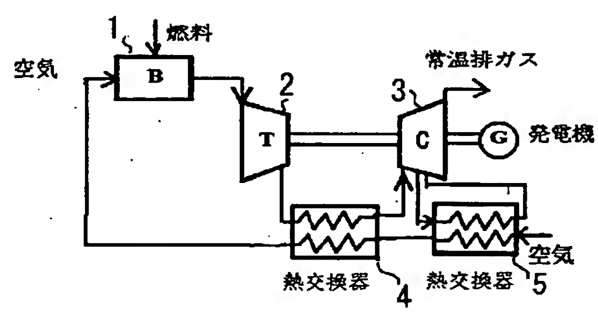
(54)【発明の名称】　ウルトラタービン

(57)【要約】
【目的】出力が３０ｋｗ程度の小型ガスタービンの熱効率を、大型の複合サイクルガスタービン並みの４５％にする手段を提供する
【構成】従来のガスタービンとは逆の順序で構成される燃焼器１、タービン２、圧縮機３からなる動力発生装置において作動空気を圧縮機出口側から逆送させるように熱交換器４，５をとうし、燃焼器１に入れる



【特許請求の範囲】

【請求項１】　タービンと圧縮機が軸で結ばれているターボ機械の当該タービン前方に燃焼器を置きその作動流体が燃焼器、タービン、圧縮機の順序で通過し外部に排出される動力発生装置において当該タービン出口と当該圧縮器出口までの高温作動ガスの冷却を当該圧縮器の吸引力等を利用して取り入れた外気との熱交換で行い当該外気を予熱して当該燃焼器に作動ガスとして流入させる方式の熱機関。

【請求項２】　請求項１の高温作動ガスの冷却を外気のほかに動力発生装置の外部に設けたポンプ等で新たに導入する流体を併用して行い予熱した外気のみを動力発生装置の燃焼器にいれて作動ガスとする熱機関。

【請求項３】請求項１の動力発生装置の外部に設けたポンプ等により流体を圧送し請求項１のタービン出口から圧縮機出口に至る高温作動ガスの冷却を行う熱機関。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】産業用ガスタービンは熱効率に優れているので近年、分散型などの小型、ホテルや病院などの非常用電源としての中型、大規模発電所の複合サイクルとしての大型にますます使われ始めた。本発明はこれらガスタービンの熱効率のさらなる向上手段として利用できるが、主としてマイクロタービンといわれる出力３０ｋｗ程度またはそれ以下の小型ガスタービンを対象にしている。

【０００２】

【従来の技術】図１は現用のガスタービンの作動サイクルを温度とエントロピーの関係で示した。エントロピーは流体損失を表す熱力学のパラメーターである。図中の１の状態で大気を吸い込み２まで圧縮し２から３まで加熱し３から４にかけてタービンで膨張させ４の状態で大気に放出して一つのサイクルが完了する。これらの過程はすべて大気より高圧の状態で行われている。４の状態の排出ガスは６００度Ｃ程度の高温なのでボイラーに再び入れ蒸気または温水にして排熱回収するコージェネレーションの普及が進んでいる。今一つの効率向上の技術としては図１の４の状態の排熱と２の状態の圧縮空気との間で熱交換し２の空気温度を高めて投入燃料の量を少なくする試みが小型ガスタービンでなされている。

【０００３】

【発明が解決しようとする課題と手段】ガスタービンの熱効率向上には、前述したように圧縮機からの高温ガスをタービン排気ガスで予熱する方式が現在、唯一絶対的なものになっているが、圧縮機出口の作動ガスはすでに高温になっており、熱交換の効率が悪い。そのため３０ｋｗの市販されている小型ガスタービンの熱効率は２５％を超える事が出来ない。小型ガスタービンでも３から５気圧程度の燃料ポンプを必要とし取り扱いが面倒で普及の妨げになっている。排熱回収にボイラー設備を必要とする。本発明はこれらの欠点を解決するものである。まず請求項１の発明の概念図を図２に示す。熱交換のために設けた外気吸入の低温側熱交換器部４で予熱された新鮮な空気は大気圧より多少低い圧力で燃焼器１に流入するので、特別の燃料ポンプを必要とせず、家庭用のガス配管等から直接供給できる利点がある。熱力学の計算を出力３０ｋｗの小型ガスタービンを想定して行ってみた。圧力比３、タービン２と圧縮機３の断熱効率を８５％、タービン入り口温度９００度Ｃ、出口温度６００度Ｃ、熱交換温度効率を８０％とすると問題の熱効率は３５％になる。このような比較的高い熱効率が得られたのは、大気温度から予熱しているためである。本発明は通常のガスタービンとは逆の順序で燃焼器１、タービンおよび２よび圧縮機３を配置しているから大気温度の空気を加熱出来るので、従来の方式より熱効率が優る。請求項１は簡潔なシステムであるが、熱効率の点などまだ改良の余地が残されているので、請求項２の発明で新たな機能を付加し、その概念図を図３に示す。タービン２出口から圧縮機３出口までの作動ガスの冷却を空気と流体の２段階で行う。すなわちタービン出口直後のガスがまだ比較的高温の間は新鮮な空気で行い、この予熱空気を作動ガスとして利用する。たとえばタービン出口６００度Ｃの作動ガスが冷却されて２００度Ｃになるまで外部から取り入れた空気で行い、その後は流体を用いて圧縮機入り口の作動ガスの温度を２０度Ｃ近くに冷却し、さらに圧縮機３を熱交換器５で中間冷却する。先に挙げた３０ｋｗの小型ガスタービンのとき、このようにすると圧縮に要する仕事が軽減され熱効率４５％に出来る。流体に水を用いれば温水がえられ、ボイラーが不要になる。流体に天然ガスを用いれば気化プラントになる。請求項３は作動ガスの冷却を流体のみで行うもので発明の概念を図４に示す。このときは作動ガスは予熱されないので効率は悪く、ただ熱交換器５で中間冷却されているので３０％程度の熱効率は保つ。気化ガスまたは温水が多量に必要なときにのみつかう。

【０００４】

【発明の効果】ガスタービンはエネルギー問題や炭酸ガス排出削減問題と深く関連するエネルギー変換のための有望な熱機関である。熱効率の向上は人類にとってますます重要度を増してくる。本発明により圧縮空気を排気ガスで加熱していた従来の方式の概念を覆し、小型のガスタービンでは今まで到達できなかった高い数値の熱効率４５％を達成できる。その効果は、従来の方式では圧縮機を中間冷却しても、燃焼前の空気温度が下がり効率向上につながらない。しかし本発明では、燃焼器がタービン前方にあるので、圧縮機を中間冷却すれば確実に熱効率が向上する。さらに本発明の最大の効果は、当該タービンを出た作動ガスを軸出力増加のため冷却する外気を予熱空気として燃料節約に都合２回活用できることにある。そのため小型ガスタービンでは不可能とされてき

た高い熱効率４５％がでる。排ガスで温水または蒸気をえるためにボイラーを必要としない。燃焼器への燃料投入に特別の装置を必要としない。燃焼が大気圧に近い状態で行え安全である。温水や天然ガスの気化が発電の副産物として得られる。

【図面の簡単な説明】

【図１】従来のガスタービンのサイクル線図

【図２】請求項１の概本発明の概念を示す断面図

【図３】請求項２の概念図

【図４】請求項３の概念図

【符号の説明】

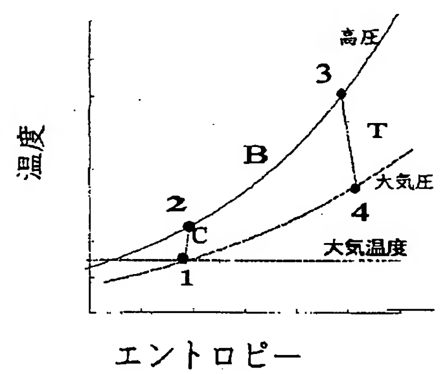
B　燃焼器

C　圧縮機

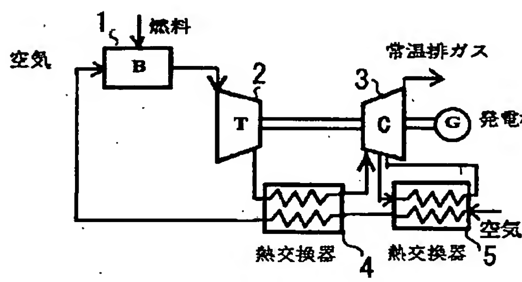
T　タービン

G　発電機

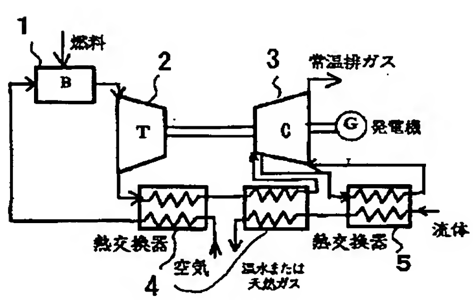
【図１】



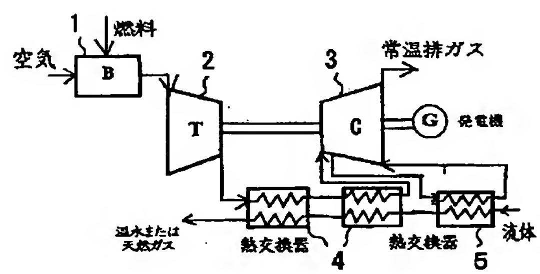
【図２】



【図３】



【図４】



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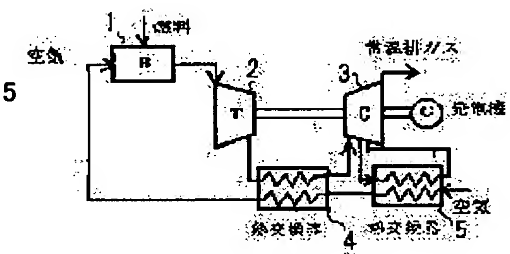

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CLAIMS

[Claim(s)]
[Claim 1] The heat engine of a method which a combustor is put [heat engine] ahead [of the turbomachinery by which the turbine and the compressor be tied with the shaft / concerned / turbine], it carries [heat engine] out by heat exchange with the open air in which the working fluid took in cooling of the elevated-temperature working medium to a turbine outlet and the compressor outlet concerned concerned using the suction force of the compressor concerned etc. in the combustor, the turbine, and the power generator that passes in order of a compressor and is discharged outside, and you carry out [heat engine] the preheating of the open air concerned, and makes it flow into the combustor concerned as working medium.
[Claim 2] The heat engine which puts only the open air which used together, performed and carried out the preheating of the newly introduced fluid with the pump which prepared cooling of the elevated-temperature working medium of claim 1 in the exterior of a power generator other than the open air into the combustor of a power generator, and makes it working medium.
[Claim 3] The heat engine which cools elevated-temperature working medium from the turbine outlet of claim 1 to [feeds a fluid with the pump formed in the exterior of the power generator of claim 1, and] a compressor outlet.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] An industrial gas turbine began to be used all the more on a large scale in recent years as the medium size as emergency power sources, such as small [, such as distributed process input output equipment,], a hotel, and a hospital, and a combined cycle of a large-scale electric power plant because it excelled in thermal efficiency. It is aimed at output 30kw extent or the small gas turbine not more than it mainly called micro turbine although this invention can be used as further improvement means of the thermal efficiency of these gas turbines.
[0002]
[Description of the Prior Art] drawing 1 -- present -- temperature and the relation of entropy showed the actuation cycle of the gas turbine of business. Entropy is the parameter showing fluid loss of thermodynamics. Inhale atmospheric air in the condition of one in drawing, compress to 2, heat from 2 to 3, apply to 4 from 3, and it is made to expand in a turbine, it emits to atmospheric air in the condition of 4, and one cycle is completed. All of these processes are performed in the high-pressure condition from atmospheric air. Since the exhaust gas of the condition of 4 is an about 600-degree C elevated temperature, it puts into a boiler again and the spread of the cogeneration which carries out and carries out exhaust heat recovery to a steam or warm water is progressing. The attempt which carries out heat exchange as a technique of the improvement in effectiveness of unsatisfactory between exhaust heat of the condition of 4 of drawing 1 and the compressed air of the condition of 2, raises the air temperature of 2 and lessens the amount of an injection fuel is made by the small gas turbine.
[0003]
[Object of the Invention and a means] Although the method which heats the elevated-temperature gas from a compressor beforehand with turbine exhaust gas as mentioned above in improvement in thermal efficiency of a gas turbine is current and what is uniquely absolute, the working medium of a compressor outlet is already an elevated temperature, and the effectiveness of heat exchange is bad. Therefore, the thermal efficiency of the small gas turbine by which 30kw(s) are marketed cannot exceed 25%. Also by the small gas turbine, the fuel pump of 3 to 5 atmospheric-pressure extent is needed, and handling is troublesome and has become the hindrance of spread. A boiler facility is needed for exhaust heat recovery. This invention solves these faults. The conceptual diagram of invention of claim 1 is first shown in drawing 2 . Since the fresh air by which the preheating was carried out in the low temperature side heat exchanger section 4 of the open air inhalation prepared for heat exchange flows into a combustor 1 by the low pressure somewhat from atmospheric pressure, a special fuel pump is not needed but there is an advantage which can carry out direct supply from gas piping for home use etc. Count of thermodynamics was performed supposing the small gas turbine of output 30kw. If the turbine inlet temperature of 900 degrees C, outlet temperature of 600 degrees C, and heat exchange temperature efficiency are made into 80% for the adiabatic efficiency of a pressure ratio 3, a turbine 2, and a compressor 3 85%, the thermal efficiency in question will become 35%. Such comparatively high thermal efficiency was acquired because the preheating was carried out from atmospheric temperature. a gas turbine usual in this invention -- a reverse order -- a combustor 1 and a turbine -- since it called two, the compressor 3 is arranged and the air of atmospheric temperature can be heated, thermal efficiency surpasses the conventional method. Although claim 1 is a brief system, since room of still amelioration, such as a point of thermal efficiency, is left behind, a new function is added by invention of claim 2, and the conceptual diagram is shown in drawing 3 . Working medium from turbine 2 outlet to compressor 3 outlet is cooled in two steps, air and a fluid. That is, it carries out by the fresh air between still comparatively elevated temperatures [gas / just

behind a turbine outlet], and it uses this tempered air as working medium. For example, it carries out with the air adopted from the outside until the working medium of 600 degrees C of turbine outlets is cooled and it becomes 200 degrees C, and the temperature of the working medium of a compressor entry is cooled at about 20 degrees C using a fluid after that, and a compressor 3 is further intrercooled by the heat exchanger 5. At the time of the small gas turbine of 30kw(s) mentioned previously, if it does in this way, the work which compression takes will be mitigated and it will be made to 45% of thermal efficiency. If water is used for a fluid, warm water will be obtained and a boiler will become unnecessary. It will become an evaporation plant if natural gas is used for a fluid. Claim 3 cools working medium only by the fluid, and shows the concept of invention to drawing 4 . Since the preheating of the working medium is not carried out at this time, effectiveness is bad, and since it merely intrercools by the heat exchanger 5, about 30% of thermal efficiency is maintained. It uses, only when evaporation gas or warm water is required for a large quantity.

[0004]

[Effect of the Invention] A gas turbine is a promising heat engine for the energy conversion deeply connected with energy problems or a carbon-dioxide-excretion reduction problem. The improvement in thermal efficiency increases significance increasingly for human beings. The concept of the conventional method of having heated the compressed air with exhaust gas by this invention is reversed, and 45% of thermal efficiency of the high numeric value which was not able to reach until now can be attained in a small gas turbine. By the conventional method, even if the effectiveness intrercools a compressor, the air temperature before combustion falls and it does not lead to the improvement in effectiveness. However, in this invention, since a combustor is ahead [turbine], if a compressor is intrercooled, thermal efficiency will improve certainly. Furthermore, the greatest effectiveness of this invention is for it to be utilizable for fuel economy two convenience by making into the tempered air the open air cooled for the increment in a brake horsepower of the working medium which came out of the turbine concerned. Therefore, in a small gas turbine, 45% of high thermal efficiency made impossible comes out. A boiler is not needed in order to obtain warm water or a steam with exhaust gas. Equipment special to the fuel injection to a combustor is not needed. Combustion can carry out in the condition near atmospheric pressure, and is safe. Evaporation of warm water or natural gas is obtained as a by-product of a generation of electrical energy.

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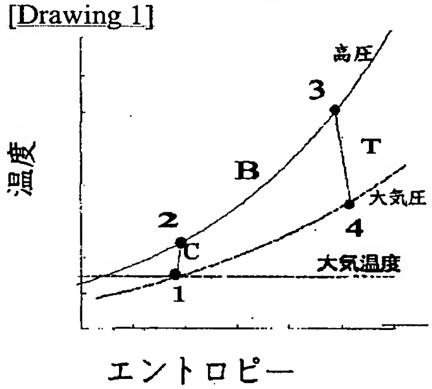
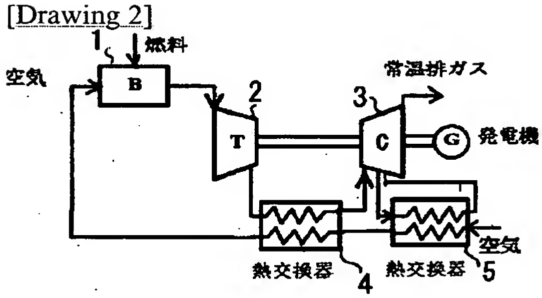
DRAWINGS

[Drawing 1]



[Drawing 2]



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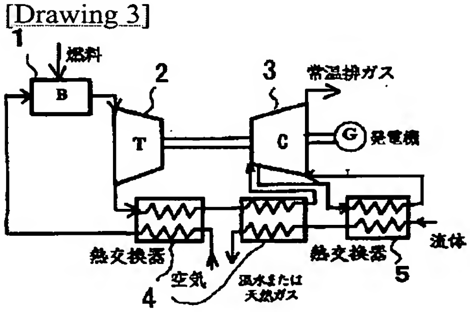

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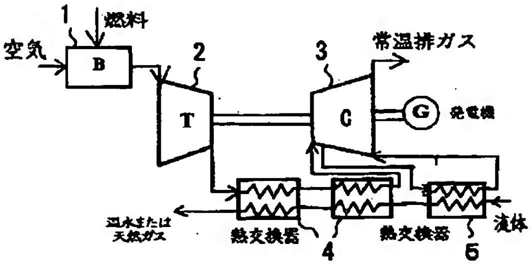

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